ONE HEALTH CASES

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Integrated Community-Based Syndromic Surveillance for Rural Settled and Mobile Populations in Two Health Districts in Chad: A Case Study Toolkit

A proof of principle study on integrated community-based syndromic surveillance was conducted between 2018 and 2020 in two rural health districts in Chad. Preliminary results showed fruitful collaboration between human and animal health sectors and community implication in diseases notification and samples collection and transport to the laboratory for analysis

Authors: **Mahamat Fayiz Abakar[1], Lamireou Didi[1], Ranya Oezelick[2], Ramadane Issa[1], Fatima Abdelrazakh Zakaria[1], Prudence Djaouga[1], Yaya Issaka[3], Hamit Kessely Bourkou[3], Youssouf Adoum Abdoulaye[4], Mahamat Ali Acyl[4], Langtar Nadji Justin[5], Nathan Naïbei[6], Helena Greter[7,8], Silja Griss[2] and Salome Dürr[2]**

Affiliations: [1]**Institut de Recherche en Élevage pour le Développement (IRED), N'Djamena, Chad**
[2]**Veterinary Public Health Institute (VPHI), Vetsuisse Faculty, University of Bern, Switzerland**
[3]**Centre de support en santé internationale (CSSI), N'Djamena, Chad**
[4]**Ministry of Public Health and Prevention, N'Djamena, Chad**

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[5]Ministry of Livestock and Animal Production, N'Djamena, Chad
[6]Communauté des Amis de l'Informatique au Tchad (CAID-Tchad), N'Djamena, Chad
[7]Swiss Tropical and Public Health Institute (SwissTPH), Allschwil, Switzerland
[8]University of Basel, Basel, Switzerland

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Abstract

A proof of principle study on integrated and community-based syndromic surveillance using mobile phones (SySMob), was carried out between 2018 and 2020 in two rural health districts in Chad, Yao and Danamadji. The study aimed to evaluate the feasibility of a new health surveillance system targeting rural mobile and settled communities and their animals in Chad. More than 30 participants from 6 health centres (3 in each district) composed of Community health workers (CHWs) and Animal community health workers (ACHWs) in addition to health centres and veterinary posts staff were trained on the use of the tools of the new health surveillance system. Biological samples collection and transport chain were established. Among the 135 suspected cases notified from both sectors, the most reported symptom in humans was fever followed by diarrhoea. In animals, diarrhoea and cough were the most reported symptoms. No human biological sample was collected, however, 26 animal blood samples suspected of anthrax and pasteurellosis were sent to the central laboratory for analysis. The results confirmed 8-positive cases of anthrax and 3 of pasteurellosis. The preliminary outcomes showed the feasibility and the adherence of local stakeholders to the new system regardless of the negative impact of COVID-19 measures during the last phase of the study. The major achievement was the integrated approach across human and animal health sectors. More research is needed to demonstrate the epidemiological, clinical and economic added value of SySMob in both sectors, which is currently in progress by the use of a cohort study.

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What is the Incremental Value that Makes this a One Health Case?

The present case study showed, to our knowledge for the first time in the central African region, the feasibility of an innovative health surveillance system integrating human and animal health priority diseases' symptoms and syndromes notification by community health workers (CHWs) and animal community health workers (ACHWs) using mobile phones. The new system increases the sensitivity of surveillance systems through community implication in the reporting process allowing for the early detection and rapid reporting of suspected cases. The new system allowed biological samples collection and transport to a central laboratory for aetiological confirmation of suspected diseases. This allowed targeted and evidence-based intervention, as well as the validation of the system by combining collected symptoms with laboratory analysis. Linking human and animal health sectors throughout the whole chain of the new system offers opportunities to optimize the training of health agents in both sectors. This could be through the sharing of knowledge, skills and competencies and facilitating sample collection and shipment to the laboratory in a coordinated manner. The cold chain could be shared mainly for sample storage and laboratories from both sectors could be involved in the biomedical analysis of suspected samples. In sum, it will improve the communication and collaboration between the sectors by the use of the same system and thus better management of zoonotic diseases in these rural communities suffering from rudimental health care services.

Learning Outcomes

After reading this case study, the careful reader will be able to design a similar study as presented here by applying the following steps:

1. Identify the agents involved in human and animal health services within a participatory process (i.e. heads of health centres and veterinary posts, CHW, ACHW).
2. Ensure involvement of relevant stakeholders from human and animal health surveillance systems from the beginning to ensure successful implementation and smooth uptake for potential scaling-up of the system.
3. Ensure appropriate training programme for CHW and ACHW including regular monitoring and evaluation sessions to maintain qualitative work and motivation. Weekly to bi-weekly phone calls and on-site visits every 3–4 months are crucial.
4. Provide the team with performant mobile phones and tablets adapted to rural areas and together with local stakeholders define the area of intervention of each CHW and ACHW (i.e. number of villages and camps or concentration zones).
5. Provide motivation for the stakeholders involved in the system. For example, provide phone calls and internet credits for the use within the system, and bikes for CHW and ACHW for displacement to their communities.
6. Develop and maintain technical IT platform in which incoming data are complied. FrontlineSMS and KoboToolbox provide a free and easy-to-use option for collecting data from the front end. The system should generate a linkage to the respective national surveillance system, such as the ISDR or DHIS-2.
7. Continuously assess incoming data including biological samples to identify the functioning of the system (engagement of the CHW and ACHW as well as technical or logistical issues).
8. Evaluate the epidemiological benefits of the new surveillance system compared to the existing one, quantify the incremental values of the One Health approach epidemiologically and economically, and communicate the outcomes with the authorities from both sectors.

Background and Context

Human and animal health share a wide range of pathogens, so-called zoonosis. Zoonotic diseases cause the majority of infections in people, with 60–70% of human pathogens are originating from animals (Taylor *et al*., 2001; Olival *et al*., 2017). The high relevance of communicable diseases in humans and animals in low- and middle-income countries (LMIC) is also reflected by its central place in the Sustainable Development Goals (SDG) (Available at: https://un.org/sustainabledevelopment/sustainable-development-goals/, accessed 1 December 2023). Within SDG 3, the concrete aim is to end the epidemics of AIDS, malaria, tuberculosis and neglected tropical diseases worldwide by 2030. To reach this aim, it is crucial to integrate

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all societies into disease prevention and control, including those with currently low access to national health system services, such as mostly rural settled and mobile communities in LMIC, and by integrating human and animal health services.

Health surveillance is the systematic and regular collection of health-related data necessary for the planning and implementation of public health practices (Available at: http://who.int/topics/public_health_surveillance, accessed 1 December 2023). Early detection of diseases is one of the primary goals in health surveillance to prevent disease transmission and spread, and eventually reduce their impact on society (Hyder *et al*., 2011). The World Health Organization (WHO) highlights the need for timely detection, appropriate reporting and diagnosis, followed by outbreak response and intervention (Kool *et al*., 2012). The global network of health and demographic surveillance systems (INDEPTH) (Available at: http://indepth-network.org, accessed 1 December 2023) came to fill the absence of reliable data on health and populations in Africa. The network includes 12 African countries, and its main objective is to provide decision makers with information related to mortality, morbidity, fertility and migration. The World Organization for Animal Health (WOAH) set up the freely accessible interface to the global health information database (WAHIS) (Available at: http://oie.int/wahis_2/public/wahid.php/Wahidhome/, accessed 1 December 2023), which contains notifications of animal diseases including zoonosis. In Africa, veterinary surveillance and alert systems exist at the regional level such as the East Africa Livestock Early Warning System (EALEWS) (Available at: http://glews.tamu.edu/africa/, accessed 1 December 2023), which provides information on the nutritional and health situation of livestock.

One Health can be defined as the collaboration of human, animal and ecosystem health that leads to added value in terms of better socio-ecological and sustainable services and/or financial savings (Zinsstag *et al*., 2015). One Health surveillance calls for continuous information exchange from surveillance systems between health sectors, and sharing of infrastructure, which brings epidemiological and financial benefits. However, the collaboration between both sectors still falls short, particularly in LMIC countries that harbour important reservoirs of emerging diseases (Abakar, 2017).

It has been demonstrated that joint human and animal health interventions, like joint vaccination campaigns in rural communities, facilitate health care for previously inaccessible pastoralist communities, and at the same time save financial resources through the integration of services between the two sectors (Schelling *et al*., 2005). Such examples of joint interventions provide the basis also for other integrated health interventions, such as disease surveillance. There is thus a need for the implementation of integrated One Health surveillance systems that are adequate from socio-cultural perspective. This is particularly relevant for remote communities in order to enable health services utilization (Münch, 2012). Culturally sensitive approaches to surveillance and interventions through participatory processes, i.e. implication of the community members, are critical as a foundation for more effective and faster surveillance and response. Community-based approaches to health surveillance and response that consider the community needs should therefore be promoted. They can synergistically combine epidemiological, anthropological, and molecular diagnostic approaches in a complementary way to anticipate endemic and emerging disease outbreaks from syndromes (Abakar, 2017).

Syndromic surveillance methods have been developed to complement traditional health data analysis to enable early detection of unusual health events (Warns-Petit *et al*., 2010). Syndromic surveillance does not target a specific disease, but looks at health-related data, such as symptoms and syndromes, and takes decisions before completing biomedical diagnosis. Today, most health surveillance systems in LMIC are based on low-tech applications within strong national institutional structures, for which syndromic surveillance is promising (Brownstein *et al*., 2008; May *et al*., 2009; Robertson *et al*., 2010). However, well-functioning and long-term sustainable surveillance systems are often non-existent in rural remote sites in Africa, due to lacking infrastructure, poor training of health personnel and lack of acceptability of health facilities by communities and CHWs (Muula and Maseko, 2006; Calain, 2007; Jefferson *et al*., 2008). In consequence, populations living in remote rural areas, do not benefit from appropriate, effective and timely surveillance systems, and therefore lack evidence-based health interventions. There is thus a need for decentralized health systems, establishment of syndromic surveillance and laboratory diagnostic structures, in order to enable health access for these remote populations (Ndiaye *et al*., 2014).

Chad is a sub-Saharan country in central Africa categorized as low income according to the World Bank, with a poverty headcount ratio (people who have less than US$1.90 available per day) of 38% in 2010 (Available at: https://databank.worldbank.org/, accessed 1 December 2023). Almost 80% of the population lives in rural areas and can be classified as agro-pastoralists (INSEED, 2014). Agro-pastoralists are mobile, semi-mobile or sedentary communities living as pastoralists, crop farmers or mixed. They live in particularly close settings with their animals, consume mostly unpasteurized milk products, and manage sick animals without adequate protection equipment, facilitating transmission of zoonotic bacterial diseases such as

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anthrax, Q-fever, brucellosis or bovine tuberculosis (Montavon *et al*., 2013). Agro-pastoralists in the Sahel are most vulnerable for exclusion from social services, including health. No specific health policies exist for mobile pastoralist communities to address essential elements such as gender disparities, high maternal mortality rates or child health (Montavon *et al*., 2013; Abakar *et al*., 2016). The Integrated Epidemiological Surveillance Service (SSEI) at the Chad Ministry of Public Health (MPH) was created in 2001 with the main objective of ensuring active surveillance of diseases with epidemic potential and target diseases of the Expanded Vaccination Program and to provide technical support to decentralized level on the collection, analysis and interpretation of health data. In addition, SSEI aims to carry urgent information necessary for emergency health measures to ensure capacity building for health workers in the field and provide feedback at all levels. The Chadian animal health surveillance system REPIMAT (*Réseau d'Epidémio-surveillance des Maladies Animales au Tchad*) was established in 1995, and was among the very first animal disease surveillance networks created in sub-Saharan Africa. Yet, these networks face major challenges linked to the lack of qualified personnel and adequate resources. The Directorate of Community Health at the MPH has elaborated a national community health policy that contains guidelines for CHWs involvement in the health system mainly through disease reporting and community sensitization. The ACHWs work usually closely with REPIMAT assisting with animal vaccination and treatment in remote areas. Both CHW and ACHW are thus linked to the governmental health system but are elected by the communities. This situation thus calls for a new, community-based One Health surveillance system based on syndromic surveillance, which is culturally adapted to the respective communities. In this case study, we present a case of such a system, called SySMob, to highlight opportunities, benefits and challenges.

Transdisciplinary Process

SySMob integrates health services from the human and animal sector, and from central to community level. On a central level, the support of the system from the Ministry of Public Health and the Ministry of Livestock was ensured from the beginning onwards. IRED, the Chadian Reference Laboratory for Animal and Zoonotic Diseases, plays a crucial role, by hosting the One Health Unit within SySMob coordination and conducting the analysis of the biological samples submitted through the system.

Involvement of health services at the local and community levels was achieved through a transdisciplinary and participatory process involving stakeholders. The stakeholders included the heads of health districts (Health Centre Officer, HCO) and veterinary districts (Veterinary Post Officer, VPO), the heads of the health centres and veterinary posts, and the CHW and ACHW. At the central level, the stakeholders included the heads of the SSEI and the REPIMAT, and the coordinator of Health of Nomads Programme at the the Ministry of Public Health. In each health centre, tow CHWs were identified; one for settled communities (villages) and the second for mobile communities (camps), as well as one ACHW in the veterinary post in the same health zone. Meetings with community representatives were organized in each involved health centre at the beginning of the study to ensure the interest and active involvement of the communities. The study objectives and the methodology of the surveillance system were presented and discussed during these working sessions. The identified CHW and ACHW were briefed with their expected tasks and involvement in the study project.

A training module targeting the involved health service agents (heads of health and veterinary centres, CHW and ACHW) was developed and used as a guide the training workshops organized in each health district in February 2019, in which more than 30 participants trained on how to use the tools (mobile phones and tablets, see "Technical platform of SySMob") of the new surveillance system (Figs. 1 and 2).

Running SySMob through the existing health system's hierarchy was important to handle ethical issues related to patients' health information. Similarly, follow-up and response towards cases were managed by the current health services, since the cases were part of the system.

Project Design and Impact

Study sites

The study was conducted in Yao and Danamadji, two rural health districts in Batha and Moyen-Chari Provinces in Chad (Fig. 3). The two health districts combined have an estimated population of 270,000 people, deserved by 31 functional health zones, defined as geographic areas of responsibility of a health

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Fig. 1. Working sessions with community health workers, animal community health workers and heads of health centres and veterinary posts in Garia: (A) and Abregna-Breka, and (B) health centres in the Yao district, February 2019.

Fig. 2. Working sessions with community health workers, animal community health workers and heads of health centres and veterinary posts in Danamadji: (A) and Dejeké-Djeké, and (B) health centres in the Danamadji district, February 2019.

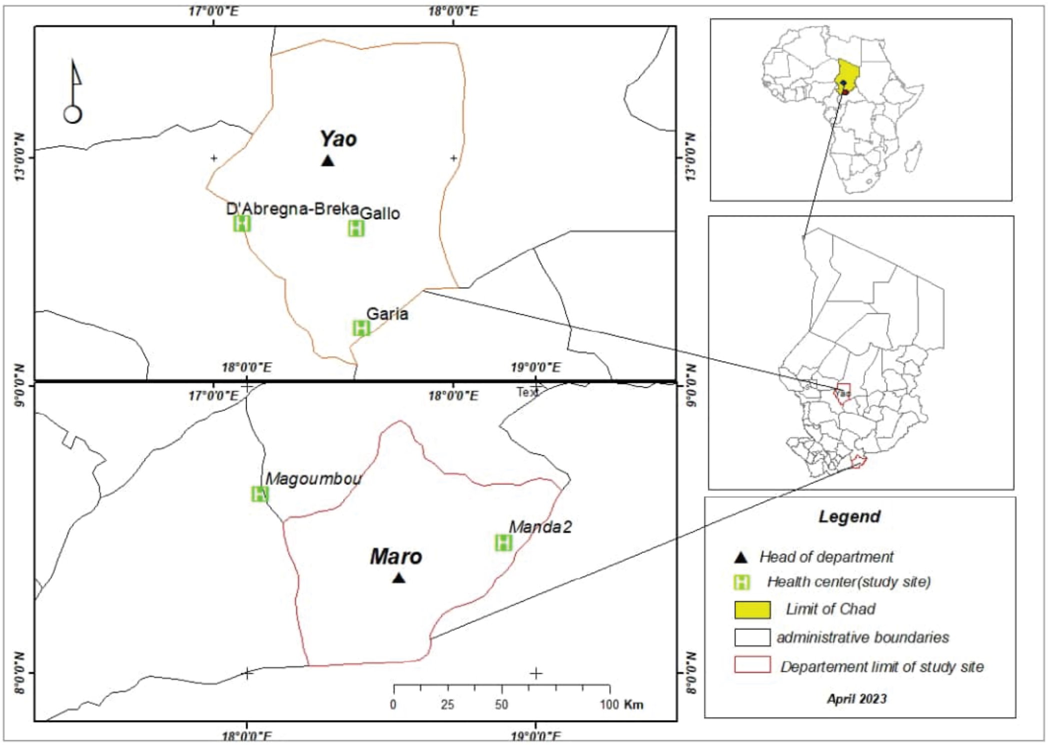

Fig. 3. Map of the study zones, Yao and Danamadji health districts, Chad (Source: Didi *et al*., 2024).

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facility (INSEED, 2014). The population in both districts is mainly composed of either ethnic groups settled in villages (mainly Boulala and Sara ethnic groups, respectively in Yao and Danamadji), or mobile pastoralist, i.e. camel, cattle and small ruminants breeders in Yao and cattle and small ruminant breeders in Danamadji (mainly Arab and Fulani pastoralist ethnic groups). Nomadic or mobile pastoralist communities are located in concentration areas or in transhumance (movement of pastoral communities with their livestock during the rainy season) (Lechthaler *et al*., 2018).

Yao and Danamadji were selected because they are the intervention zones of PADS (*Programme d'Appui aux District Sanitaire au Tchad*), a Swiss Development and Cooperation Agency supported health systems development project. SySMob was implemented in synergy and collaboration with PADS. Our recent studies in the same zones revealed that Q fever, Rift Valley Fever and brucellosis were present among human and animal populations of Yao and Danamadji (Özcelik *et al*., 2023). A community-based symptoms reporting study showed that cough and diarrhoea as the most frequent symptoms reported simultaneously in humans and animals and it was significantly higher during the cold season, and diarrhoea was observed more frequently during the wet season (Doras *et al*., 2024). These studies were conducted as a benchmark for the implementation of SySMob demonstrating the prevalence of important zoonotic diseases and the feasibility of collecting relevant health data in humans and animals involving the community in rural settings in Africa.

Technical platform of SySMob

The SySMob system uses a cascade of information transmission between different health agents involved from peripheral to central level. The chronological steps 1–5 are as follows (Fig. 4): The CHWs or ACHWs, respectively, send a text message following a specified code with the disease symptoms of a human or animal case to a central data server (step 1). The server automatically sends a message to the members of the One Health Unit (currently consisting of the research team), as well as to the concerned district and health zones (step 2) using FrontlineSMS (Available at: http://frontlinesms.com, accessed 1 December 2023). The so informed HCO or VPO calls the CHW or ACHW to follow-up on details, and they complete an electronic questionnaire (using the freeware KoboCollect: Available at: http://kobotoolbox.org, accessed 1 December 2023) that systematically collects information about the case and the health status in the same household/herd or – in suspicion of a highly infectious disease – about the entire community (step 3). A question was added to collect information on whether the same symptoms as observed in the case are also observed in the animal population (for human cases reported) or the human population (for animal cases reported). This enabled the analysis of common symptoms occurring in humans and animals. The information gathered in the questionnaire will be automatically transferred to the central server and

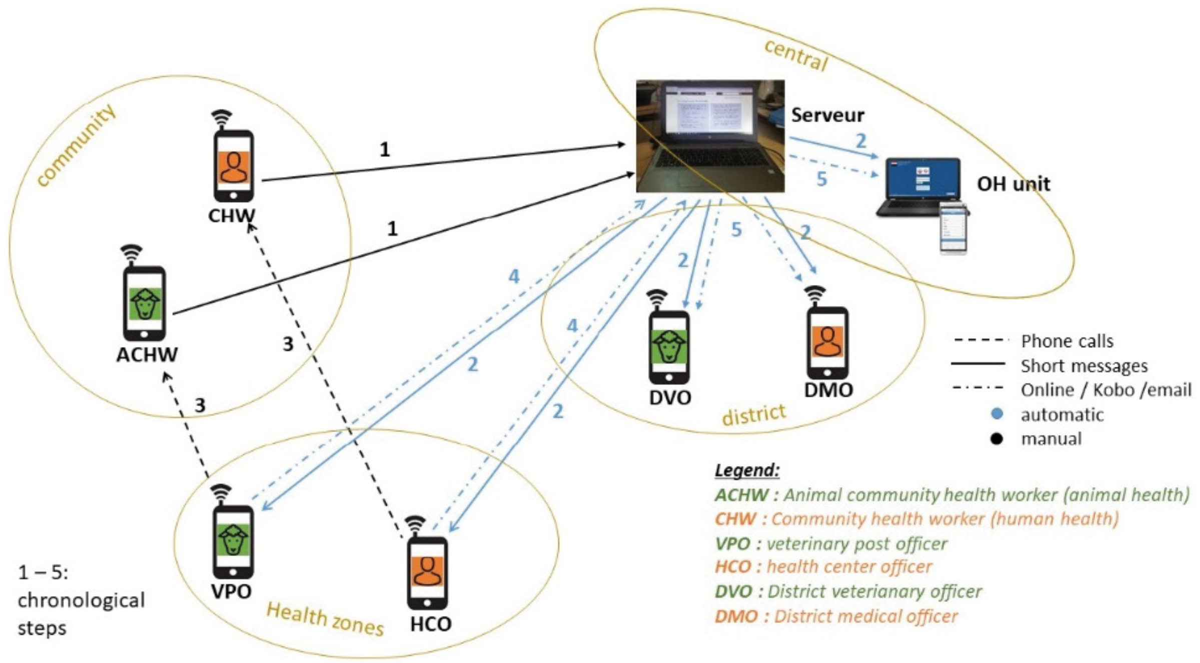

Fig. 4. Technical platform of SySMob to collect community-based syndromic data from the human and animal population and an automatic exchange of such information between the sectors.

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automatically to the One Health Unit (step 4) and to the district medical officer and district veterinary officer (step 5), enabling them to initiate targeted responses as required. With this process, the data collected per reported case include detailed information on the patients and/or diseased animals and the humans and animals living in the same household or community, as well as the time between the first report and intervention.

Pilot testing and evaluation of SySMob

The first phase of pilot testing of SySMob took place from January to April 2018 aiming at testing the feasibility of the new system on a small scale in three health centres (Galo, Garia and Abregna-Breka) in Yao health district and two health centres (Djeke-Djeke and Magoumbo) in the Danamadji health district. During this phase, the focus was on set on the evaluation of the technical system of SySMob, i.e. whether the text messages are well received by the central data server and automatically forwarded to the HCO, VPO and One Health Unit.

An evaluation workshop was organized in May 2019 to assess the strengths and weaknesses of the new system in order to move towards its implementation. It has been noted that all technical aspects related to the software used in the system were successfully functioning. The main recommendations were to ensure the adherence of all involved health agents and their commitment to the project. Implication of the personnel of the existing governmental surveillance systems in both sectors was appointed as a key element in the success of the implementation of SySMob. The weak points were the limited coverage of the mobile phone network in some areas and the poor level of French language by some of the CHW and ACHW involved in the study. Although the training workshops were held bilingually in Arabic and French, this highlighted the need to also use the Arabic language for the use of mobile phones, and ideally the acceptance of Arabic for the coded text messages, a step that has not been implemented yet. Providing the CHW and ACHW with transport means (bicycles) to circulate between communities and mobile phone communication credit was recommended to guarantee more sustainable engagement throughout the project's implementation. Appropriation of health services by the community needs to be ensured to guarantee the sustainability of these actions. Typically, the election of CHW and ACHW is undertaken by the communities, which is a key factor in the success of SySMob, as well as for health services in general.

A transport chain for collecting and sending samples to the central laboratory at IRED has been set up. Contracts with public transport agencies as well as motorcycle taxis have been established for sample delivery to the laboratory, accordingly has already been successfully used for decentralized rabies diagnosis in Chad (Léchenne *et al*., 2021). Heads of health centres and veterinary posts were trained in biosafety measures regarding sample collection. Personal protective equipment, sampling and transport materials were made available to ensure smooth biological samples transfer to IRED for aetiological diagnosis.

After the evaluation workshop in May 2019, updated electronic-based questionnaires for data collection at the community, health facility and laboratory levels have been developed. The symptoms to be reported, the samples to be collected and the diseases to be diagnosed have been described in this manual. An additional health centre, Manda II, in the Danamadji district was included in the study sites.

From January 2020 onwards, the second intensive data collection phase was launched. However, the first case of COVID-19 reported in Chad in March 2020, affected negatively SySMob for several months. The main factor was the movement restrictions between different cities and the lockdown of N'Djamena the capital city of Chad. However, two monitoring and evaluation missions were conducted in May 2020 and September 2021.

Preliminary results

The CHWs and ACHWs were able to report symptoms of diseases in humans and animals throughout the implementation period of SySMob. This not only demonstrated the technical functioning of the system but also highlighted that the community was able to report suspicions of diseases based on symptoms in humans and animals.

In total, 135 suspected cases were notified from February to July 2020. Of those, 124 (92%) cases were reported from health centres and 11 (8%) cases from veterinary posts. Danamadji health district reported 96 (71%) cases while Yao health district reported 39 (29%) cases (Fig. 5).

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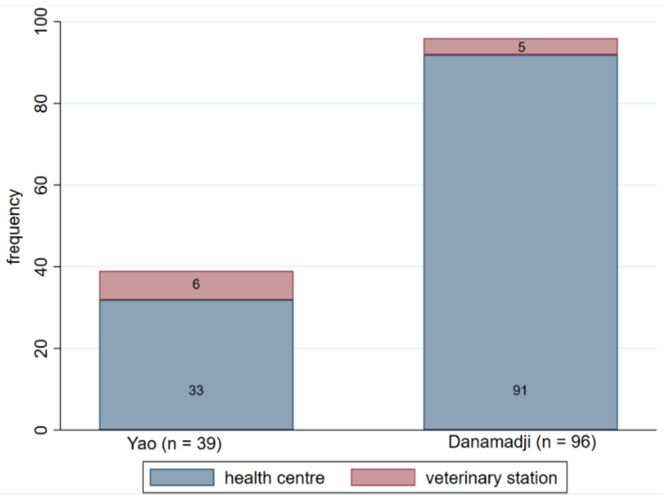

Fig. 5. Distribution of cases reported to by the community-based syndromic surveillance system (called SySMob) in human and animal health sectors and in two health districts in rural Chad.

Regarding human cases, 95% (86/91) of the cases reported in Danamadji came from the Djéké-Djéké health centre. As for Yao health district, 61% (20/33) of the reports were carried out by the centre of Galo. Suspicions of animal diseases in Yao health centre were mainly made by the veterinary post of Abrégna-Bréka (61%, 5/6). In Danamadji, most of animal suspicions were reported by the Djéké-Djéké veterinary post (80%, 4/5) (Fig. 6).

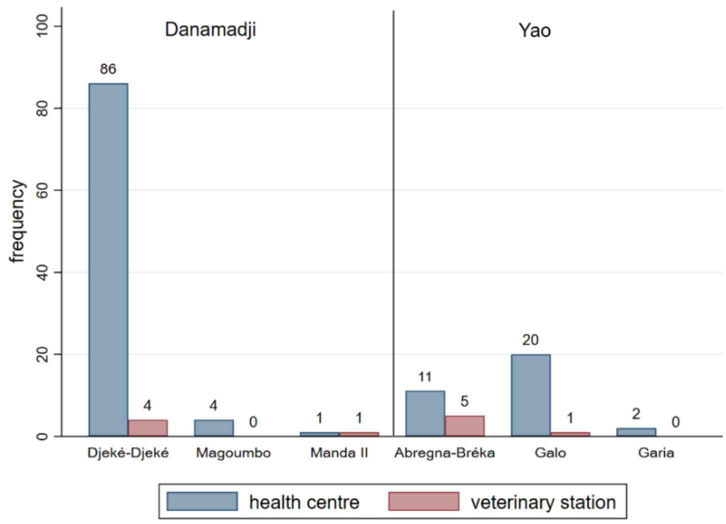

Fig. 6. Distribution of health cases reported by health centres and veterinary posts through the community-based syndromic surveillance system (called SySMob) in human and animal health sectors and in two health districts in rural Chad.

The most reported symptom in human health was fever (46%, 57/124) followed by diarrhoea (16%, 20/124). In animal health, diarrhoea (n = 3), then abortion (n = 2) and cough (n = 2) were the most reported symptoms (Fig. 7).

The weekly number of cases reported over time varied between 0–9 in humans, and 0–4 in animals in both health districts, with the exception of 1 peak of human cases reported in Danamadji in the week of 29 June 2020. These 40 cases were reported by the same CHW within 2 days, and include 26 fever cases, 3 skin problem cases, 3 cases of difficulties during pregnancy, and 8 other cases (Fig. 8). The fact that the cases were reported from 20 different villages suggests that the peak was caused by a reporting bias of the CHW, i.e. recording the cases observed over the past time within 2 days, rather than by an outbreak.

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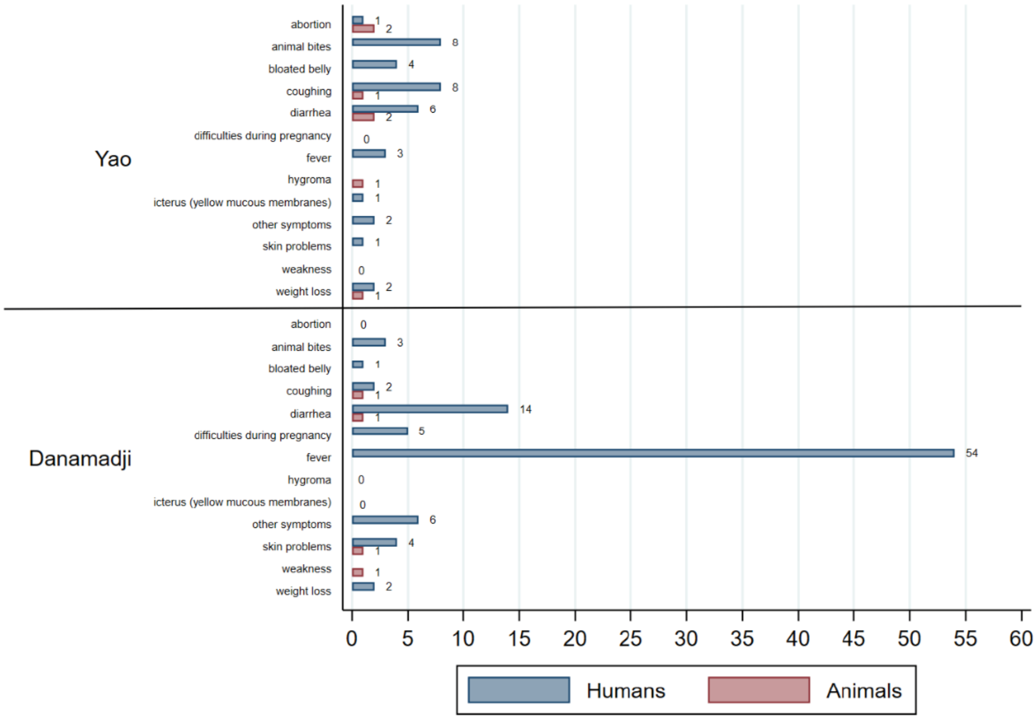

Fig. 7. Frequency of symptoms reported in human and animal health sectors by the community-based syndromic surveillance system (called SySMob) in two health districts in rural Chad.

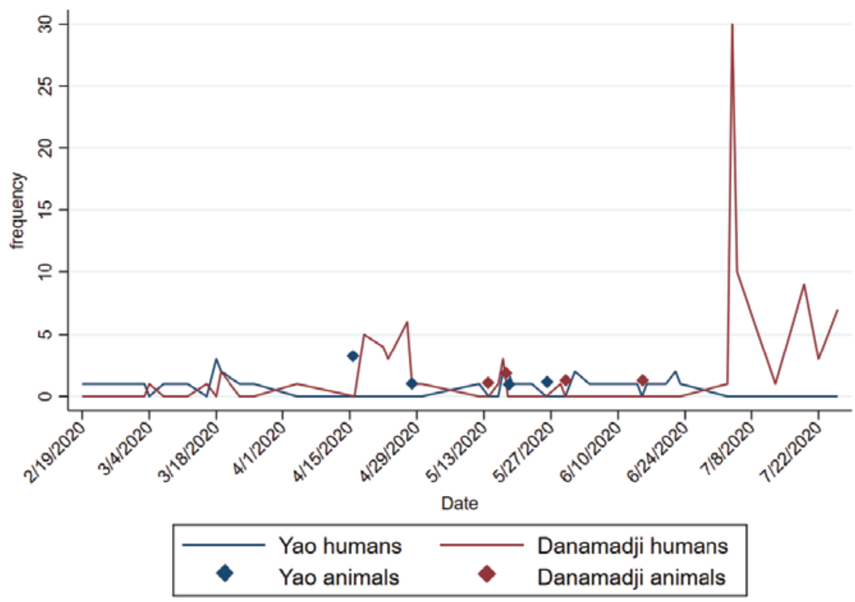

Fig. 8. Overview of case notifications by week of symptoms reported in human and animal health sectors by the community-based syndromic surveillance system (called SySMob) in two health districts, Yao and Danamadji, in rural Chad.

During the same time period, no human biological sample was collected, however, 26 animal blood samples suspected of anthrax and pasteurellosis were sent to IRED for analysis. The results confirmed eight positive cases of anthrax and three cases of pasteurellosis.

Challenges and limitations

At the beginning of the project, bringing together different stakeholders who usually work separately was challenging but rapidly and steadily improved throughout the process and years. A particular challenge

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is the frequent change of personnel on the level of HCP and VPO, who are in crucial positions to sustain SySMob. Personal relations and trust between them and the CHW and ACHW are essential, and they need some time to be re-established after a change in personnel. Technical issues related to the quality of phone reception coverage and the performance of tablets and mobile phones were among the weakest elements in the reporting chain. The COVID-19 pandemic heavily affected the implementation of SySMob and interrupted the great momentum and engagement of all involved stakeholders. Lack of motivation was one of the major limitations leading to less engagement of involved stakeholders at all levels, and CHW and ACHWs in particular. Consequent follow-up of stakeholders' activities and their support is essential, i.e. monthly follow-up meetings. Finally, as a health systems research project, it was particularly challenging for SySMob to provide an immediate outcome and measurable results.

Project Outlook

- 12-month cohort study to evaluate its sensitivity and time to detection of new cases in comparison with the existing surveillance system, to be started in June 2024 in the same study sites.
- Assessment of the economic effort of the system.
- Quantification of the added values of the One Health approach (epidemiologically and economically)
- Promotion of submission of human biological samples.
- Development of decision support tool for interventions include an algorithm based on the use of the symptoms and laboratory diagnostic results data collected by SySMob. Such a decision support tool would be able to identify the most-likely diagnosis based on the symptoms collected by SySmob.
- Link the detection to the intervention and follow-up by health officials in both sectors.
- Integration of demography data collection (birth and death) in human and animal populations within SySMob to optimize resources for data collection.
- Provide the health districts and veterinary sectors with a road map for integrating CHWs and ACHWs in their routine activities including the budget.

Conclusions

The study has a high potential in disease surveillance aiming at early detection of emergent and endemic diseases, especially zoonosis, in remote areas and scalability in other regions in Chad and widely in rural Africa.

Large enough investment is needed at the beginning; however, it becomes reasonable once the system is established and well-functioning. There is also a need to link such a surveillance system directly with the existing health services to ensure its sustainability. This could be achieved by working with the personnel appointed by the government, and by linking the technical platform of SySMob to the national surveillance database. The newly created national One Health platform of Chad could play a central role in ensuring the smooth uptake of the new system within intersectoral and transdisciplinary processes.

Group Discussion Questions

1. What are the main challenges related to the implication of CHW and ACHW in a such surveillance system and their commitment through the process?
2. Discuss the issues related to cross-sector collaboration between human and animal health sectors at all levels of a surveillance system such as SySMob.
3. Discuss the potential added value of SySMob from health and economic perspective compared with existing surveillance systems in both sectors.

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Conflict of interest

The authors have no conflicts of interest to declare.

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